Atty. Dkt. 461-171
ND-P051-US

U.S. PATENT APPLICATION

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Invention: HIGH-PRESSURE FUEL SUPPLYING APPARATUS

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SPECIFICATION

HIGH-PRESSURE FUEL SUPPLYING APPARATUS

1. Field of the Invention

The present invention relates to a high-pressure fuel supplying apparatus wherein a fuel from a fuel tank is highly pressurized and supplied to a common-rail.

2. Description of the Related Art

As a fuel injection apparatus used for a diesel engine, etc., an accumulating fuel injection apparatus using a common-rail is known. The accumulating fuel injection apparatus is comprised of a common-rail for accumulating a high-pressure fuel, an injector for injecting the high-pressure fuel accumulated in the common-rail, and a high-pressure fuel supplying apparatus for highly pressurizing a fuel from a fuel tank and supplying the fuel to the common-rail.

The high-pressure fuel supplying apparatus is comprised of a low-pressure fuel supplying system having a feed pump for supplying the fuel from the fuel tank to a high-pressure pump, a fuel supply control system having a fuel supply control valve for adjusting the amount of fuel to be supplied from the feed pump to the high-pressure pump, and a high-pressure fuel discharging system having the high-pressure pump for pressurizing the regulated low-pressure fuel and discharging the high-pressure fuel to the common-rail. The low-pressure fuel supplying system, the fuel supply control system and the high-pressure fuel discharging system are integrally formed as a fuel injection pump. In the fuel injection pump, described below, the low-pressure fuel supplying system, the fuel supply control system and the high-pressure fuel discharging system are integrally provided.

The high-pressure pump mounted on the fuel injection pump requires a large driving torque so as to pressurize the fuel to a high pressure. Thus, in order

to drive the high-pressure pump by the output of an internal-combustion engine (hereinafter referred to as an engine), the fuel injection pump is mounted directly to the engine or in the vicinity thereof.

Because of the restrictions to the position of the fuel injection pump which must be mounted in the vicinity of the engine, it is not easy to provide a space large enough to accomodate the fuel injection pump, which is hard to downsize, in the vicinity of the engine, in a small engine compartment.

Especially, in recent years, in a small vehicle, such as a small passenger automobile, wherein a small-sized engine is housed in a small engine compartment, it is necessary that components of the engine including the fuel injection pump are housed in the small engine compartment. However, it is very difficult to arrange the fuel injection pump, which is hard to downsize, in the vicinity of the engine, because of the limited space.

Also, the feed pump, the fuel supply control valve, and the high-pressure pump, provided in the fuel injection pump are specially designed for the types or kinds of the fuel injection pump. Accordingly, the feed pump, the fuel supply control valve and the high-pressure pump are each expensive, thus resulting in an increase in the manufacturing cost of the fuel injection pump (high-pressure fuel supplying apparatus).

SUMMARY OF THE INVENTION

The present invention has been completed in view of the above circumstances. An object of the present invention resides in providing an inexpensive high-pressure fuel supplying apparatus having a high degree of flexibility in mounting.

In the high-pressure fuel supplying apparatus according to an aspect of a first embodiment, the low-pressure fuel supplying system, the fuel supply control system and the high-pressure fuel discharging system are

independently provided as separate pieces, and the low-pressure fuel supplying system, the fuel supply control system and the high-pressure fuel discharging system are connected by a fuel pipe.

By separately providing the low-pressure fuel supplying system, the fuel supply control system and the high-pressure fuel discharging system, the size of the low-pressure fuel supplying system, the size of the fuel supply control system and the size of the high-pressure fuel discharging system, independently from one another, can be reduced relative to the size of the fuel injection pump.

Only the high-pressure pump has restrictions regarding mounting in the vicinity of the engine. It is easier to provide a space for mounting the high-pressure fuel discharging system, which is smaller than the fuel injection pump that is hard to downsize, near the engine.

The low-pressure fuel supplying system and the fuel supply control system have no restriction in mounting and they can be mounted in any empty space.

Namely, by adopting a means of the first embodiment, the mountability of the high-pressure fuel supplying apparatus is extremely increased compared to the prior arts.

Also, general-purpose devices can be used for all of the feed pump, the fuel supply control valve and the high-pressure pump, or a part of them (for example, the feed pump or the fuel supply control valve, or both of the feed pump and the fuel supply control valve). Thus, the total cost for the feed pump, the fuel supply control valve and the high-pressure pump can be kept low, and a low-price high-pressure fuel supplying apparatus can be provided.

In the high-pressure fuel supplying apparatus according to an aspect of a second embodiment, the low-pressure fuel supplying system and the fuel supply control system are integrally provided, the high-pressure

fuel discharging system is independently provided as a separate piece, and the fuel supply control system and the high-pressure fuel discharging system are connected by a fuel pipe.

By independently providing the high-pressure fuel discharging system, the size of the integrally provided low-pressure fuel supplying system and fuel supply control system can be reduced relative to the fuel injection pump. The size of the separate high-pressure fuel discharging system can be reduced relative to the fuel injection pump.

As in the above mentioned means of the first embodiment, only the high-pressure pump must be mounted in the vicinity of the engine. It is easier to provide a space for mounting the high-pressure fuel discharging system, which is smaller than the fuel injection pump, near the engine.

As the integrally provided low-pressure fuel supplying system and fuel supply control system have no restriction in mounting, they can be mounted in any empty space.

Namely, by adopting a means of the second embodiment, the mountability of the high-pressure fuel supplying apparatus is extremely increased compared to the prior arts.

Also, general-purpose devices can be used for all of the feed pump, the fuel supply control valve and the high-pressure pump, or a part of them (for example, the feed pump or the fuel supply control valve, or both of the feed pump and the fuel supply control valve). Thus, the total cost for the feed pump, the fuel supply control valve and the high-pressure pump can be kept low, and a low-price high-pressure fuel supplying apparatus can be provided.

The fuel supply control valve of the high-pressure fuel supplying apparatus according to an aspect of a third embodiment is an electromagnetic fuel supply

control valve which opens/closes a fuel passage, for feeding the fuel to the high-pressure pump, in response to an electric signal.

By using the electromagnetic fuel supply control valve, which can be activated without using the output of the engine, the fuel supply control valve can be located in any place.

The feed pump of the high-pressure fuel supplying apparatus according to an aspect of a fourth embodiment is driven by an electric motor.

By driving the feed pump using the electric motor, the feed pump can be activated without using the output of the engine, and the feed pump can be located in any place.

The feed pump of the high-pressure fuel supplying apparatus according to an aspect of a fifth embodiment is driven by the engine or the high-pressure pump through a power transmitting means such as a gear or a chain.

If a space for mounting the feed pump can be provided near the engine or the high-pressure pump, the feed pump can be driven by the power of the engine or the high-pressure pump.

The present invention may be more fully understood from the description of preferred embodiments of the invention set forth below, together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

Fig. 1 is a schematic view of a high-pressure fuel supplying apparatus according to a first embodiment.

Fig. 2 is a schematic view of a high-pressure fuel supplying apparatus according to a second embodiment.

Fig. 3 is a schematic view of a modified example of a high-pressure fuel supplying apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The embodiments of the present invention will be explained using two embodiments and a modified example.

First, the first embodiment will be explained with reference to Fig. 1. Fig. 1 is a schematic view of a high-pressure fuel supplying apparatus mounted on an accumulating fuel injection apparatus.

The accumulating fuel injection apparatus comprises a common-rail (not shown) for accumulating a high-pressure fuel, a plurality of injectors (not shown) for injecting the high-pressure fuel accumulated in the common-rail to each cylinder of an engine (not shown), and a high-pressure fuel supplying apparatus for compressing the fuel in a fuel tank 1 to a high pressure and feeding the pressurized fuel to the common-rail.

The high-pressure fuel supplying apparatus is, as shown in Fig. 1, provided with a high-pressure fuel discharging system 3 having a high-pressure pump 2 for discharging the high-pressure fuel to the common-rail, a low-pressure fuel supplying system 5 having a feed pump 4 for feeding the fuel in the fuel tank 1 to the high-pressure pump 2, and a fuel supply control system 7 having a fuel supply control valve 6 (SCV) for adjusting the amount of the fuel to be fed from the feed pump 4 to the high-pressure pump 2.

The low-pressure fuel supplying system 5 is provided with a regulator valve in addition to the feed pump 4.

The feed pump 4 is comprised of a trochoid pump, a vane pump, an external gear pump, or an internal gear pump, etc., to suck the fuel, accumulated in the fuel tank 1, through the fuel filter 9 and feed the fuel to the high-pressure pump 2 through the fuel supply control valve 6. The feed pump 4 in this embodiment is driven by an electric motor (not shown) which generates a rotating force when energized.

The regulator valve 8 is arranged in a fuel passage which connects the discharge side and the feed side of the feed pump 4. The regulator valve opens when the discharge pressure of the feed pump 4 increases to a predetermined pressure, so as to prevent the discharge

pressure of the feed pump 4 from exceeding the predetermined pressure.

The fuel supply control valve 6 mounted on the fuel supply control system 7 is an electromagnetic fuel supply control valve which controls the amount of fuel to be fed to the high-pressure pump 2 by opening/closing the fuel passage for feeding the fuel to the high-pressure pump 2, in response to an electric signal (on/off signal) supplied from an ECU (Engine Control Unit, not shown).

As the fuel supply control valve 6 controls the fuel amount to be fed to the high-pressure pump 2, the fuel amount discharged from the high-pressure pump 2 is controlled, and the fuel pressure of the common-rail is controlled.

The high-pressure fuel discharging system 3 is provided with an intake valve 11 and a discharge valve 12, in addition to the high-pressure pump 2.

The high-pressure pump 2 is comprised of one or a plurality of plunger pumps driven by the engine.

The high-pressure pump 2 of the present embodiment comprises an eccentric cam 14 which is provided on a cam shaft 13 that is rotationally driven by the rotational output of the engine and rotates eccentrically with respect to a rotating axis of the cam shaft 13, a cam ring 15 mounted rotatably around the eccentric cam 14, and a plunger 18 reciprocating within a cylinder 17 while being pressed on the peripheral surface of the cam ring 15 by a spring 16.

When the plunger 18 descends (moves toward the axis of rotation), a volume of a pressure chamber 19 is expanded so that the pressure of the pressure chamber 19 is decreased and the discharge valve 12 is closed. At the same time, the intake valve 11 is opened so that the fuel which is fed from the feed pump 4 and whose amount is regulated by the fuel supply control valve 6 is introduced into the pressure chamber 19.

Conversely, when the plunger 18 ascends (moves in

the direction opposite to the axis of rotation), the volume of the pressure chamber 19 is reduced so that the fuel in the pressure chamber 19 is pressurized and the intake valve 11 is closed. Then, when the pressure of the fuel pressurized in the pressure chamber 19 reaches a predetermined pressure, the discharge valve 12 is opened to discharge the high-pressure fuel pressurized in the pressure chamber 19 toward the common-rail.

A part of the fuel supplied to the high-pressure fuel discharging system 3 is supplied to a cam compartment 22 which surrounds the periphery of the cam ring 15 through an orifice 21, and surplus fuel in the cam compartment 22 is returned to the fuel tank 1 through the fuel pipe 23 for returning the fuel.

Next, the features of the first embodiment will be explained. As is explained in "2. Description of the Related Art", in the conventional high-pressure fuel supplying apparatus, the high-pressure fuel discharging system 3, the low-pressure fuel supplying system 5 and the fuel supply control system 7 are integrally formed as a fuel injection pump. Because the high-pressure pump 2 is driven by the output of the engine, it is necessary to mount the fuel injection pump directly to the engine or in the vicinity of the engine.

However, it is not easy to provide a space large enough to mount the fuel injection pump, which is hard to downsize, near the engine in the small engine compartment.

To this end, in the high-pressure fuel supplying apparatus of the embodiment, as shown by the dashed lines in Fig. 1, the low-pressure fuel supplying system 5, the fuel supply control system 7 and the high-pressure fuel discharging system 3 are independently provided as separate pieces, and are connected by the fuel pipe 23.

By separately providing the low-pressure fuel supplying system 5, the fuel supply control system 7 and the high-pressure fuel discharging system 3, the size of

the low-pressure fuel supplying system 5, the fuel supply control system 7 and the high-pressure fuel discharging system 3, independently from one another, can be reduced relative to the fuel injection pump.

Because the cam shaft 13 of the high-pressure pump 2 is driven by the engine, it is necessary to provide a space for mounting the high-pressure fuel discharging system 3 near the engine. In other words, only the high-pressure fuel discharging system 3 having the high-pressure pump 2 requires a mounting space near the engine.

Because the high-pressure fuel discharging system 3 is smaller than the fuel injection pump, it is much easier to provide a space for mounting the high-pressure fuel discharging system 3 near the engine than to provide a space for mounting the fuel injection pump, which is hard to downsize, near the engine.

On the other hand, because the feed pump is driven by an electric motor, the feed pump 4 can be located at any place with no restriction. Also, use of the fuel supply control valve 6 in the form of an electromagnetic fuel supply control valve makes it possible to mount the fuel supply control valve 6 at any place.

Accordingly, as the low-pressure fuel supplying system 5 and the supply control system 7 have no restriction in mounting, they can be mounted in any empty space in the engine compartment.

Namely, according to the high-pressure fuel supplying apparatus of the present embodiment, the mountability to a vehicle is extremely increased compared to the prior arts.

Also, general-purpose devices can be used for all (or some) of the feed pump 4, the fuel supply control valve 6 and the high-pressure pump 2. Thus, the total cost for the feed pump 4, the fuel supply control valve 6 and the high-pressure pump 2 can be kept low, and a low-price high-pressure fuel supplying apparatus can be

provided.

Next, a second embodiment will be explained with reference to Fig. 2. The same reference numerals as those used in the first embodiment indicate like functioning components.

In the above first embodiment, the low-pressure fuel supplying system 5, the fuel supply control system 7 and the high-pressure fuel discharging system 3 are independently provided as separate pieces.

Alternatively, in the high-pressure fuel supplying apparatus of the second embodiment, as shown by the dashed lines in Fig. 2, the low-pressure fuel supplying system 5 and the fuel supply control system 7 are integrated to be a low-pressure fuel supply control system 24. As in the first embodiment, the high-pressure fuel discharging system 3 is provided as a separate piece. The fuel supply control system 7 of the low-pressure fuel supply control system 24 is connected to the high-pressure fuel discharging system 3 by the fuel pipe 23.

With this arrangement, as in the first embodiment, only the high-pressure fuel discharging system 3, which is small relative to the fuel injection pump, should be mounted near the engine, and it becomes easier to provide a space for mounting the high-pressure fuel discharging system 3 near the engine.

On the other hand, the low-pressure fuel supply control system 24 having, integral therewith, the low-pressure fuel supplying system 5 and the fuel supply control system 7 has no restriction in mounting, and it can be mounted in any empty space.

Namely, the high-pressure fuel supplying apparatus of the second embodiment also has a good mountability to a vehicle, as in the first embodiment.

As in the first embodiment, general-purpose devices can be used for all (or some) of the feed pump 4, the fuel supply control valve 6 and the high-pressure pump 2.

Thus, the total cost for the feed pump 4, the fuel supply control valve 6 and the high-pressure pump 2 can be kept low, and a low-price high-pressure fuel supplying apparatus can be provided.

Lastly, a modified example will be explained. In the above-mentioned embodiments, the fuel overflowing from the regulator valve 8 is returned to the suction side of the feed pump 4. However, as shown in Fig. 3, the fuel overflowing from the regulator valve 8 can be returned to the fuel tank 1.

In the above embodiments, the fuel filter 9 is arranged on the suction side of the feed pump 4. However, as shown in Fig. 3, the fuel filter 9 can be arranged between the feed pump 4 and the fuel supply control valve 6.

In the above embodiments, the feed pump 4 is driven by the electric motor so that it can be mounted in any place. However, if a space for mounting the feed pump 4 can be obtained near the engine or the high-pressure pump 2, the feed pump 4 can be placed in that space and driven by the torque of the engine or the high-pressure pump 2 transmitted thereto through the power transmitting means such as a gear or a chain.

While the invention has been described by reference to specific embodiments chosen for purposes of illustration, it should be apparent that numerous modifications could be made thereto, by those skilled in the art, without departing from the basic concept and scope of the invention.